6.5 aqueous solution comprising 500 mg/liter of sodium chloride at an operation pressure of 5 kg/cm^2 and at a temperature of 25 °C.

REMARKS

The Applicant would like to thank the Examiner for his careful review of the application.

I. Information Disclosure Statement

The Applicant thanks the Examiner for noting that certain references referenced in the specification have not, as yet, been properly included as part of an Information Disclosure Statement (IDS). Accordingly, the Applicant will submit an IDS listing for any reference discussed in the specification that has not previously been cited. No representation as to the relevance of any of the references is made by the filing of this document. The Applicant does note, however, that although JP 63-17521 was referenced in the specification, this is a typographical error, and the correct reference is JP 61-17521, an abstract of which is enclosed for the Examiner's consideration.

II. Disposition of Claims

Claims 1 and 4-6 are pending in the application. Claim 1 has been amended to recite that the thin film contains an amino group directly connected to an aromatic ring. Support for this amendment may be found, for example, on page 4 of the specification as originally filed.

III. Rejections Under 35 U.S.C. §§ 102 and 103

The Applicant's invention relates to a highly permeable composite reverse osmosis membrane, which is prepared by cross-linking polyvinyl alcohol-based amine compounds with

substantially monomeric compounds that have at least two functional groups that can react with the amino groups on the polyvinyl alcohol-based amine compounds. (Specification, p. 4, lines 6-9). The Applicant acknowledges that polyvinyl alcohol-based reverse osmosis membranes are known in the art.

For example, published Japanese Patent Application Nos. 59-27202 and 61-17521 disclosed polyvinyl alcohol-based reverse osmosis membranes having high salt rejection efficiencies. (Specification, p. 1, lines 30-32). However, these prior art membranes have high salt rejection (e.g., > 90%) and low water permeability (e.g., < 0.2 $m^3/m^2 \cdot d \cdot kg/cm^2$). (Specification, p. 1, lines 35-36). In contrast, membranes of the present invention have low salt rejection (e.g., < 80%) and high water permeability (e.g., > 1.0 $m^3/m^2 \cdot d$ at 5 kg/cm^2). (Specification, p. 3, lines 26-32). When the salt rejection exceeds 80%, insoluble ingredients are easily deposited under a high recovery condition. (Specification, p. 5, lines 27-28).

Membranes of the present invention are prepared by interfacial cross-linking. The Applicant notes that while the claims relate to a product formed from a specified process, in polymer chemistry, as is well-known by the Examiner, the process used to form the polymer can dramatically effect the polymer microstructure and, as result, the properties of the polymer. Therefore, claim 1 has been amended to recite that the present invention uses an interfacial cross-linking polymerization.

In a typical reaction disclosed in the present invention, a microporous support is contacted with a polyvinyl alcohol-based amine compound in a polar solvent (0.01-20% by weight) followed by an organic (non-polar) solution containing an amino-reactive compound (0.01-5% by weight). The cross-linking is typically carried out at 40-80 °C for 10 seconds to 60

minutes. (Specification, p. 6, line 37 – p. 7, line 6). Addition of a material whose solubility parameter ranges from 8 to 14 $(cal/cm^3)^{1/2}$ in the cross-linking reaction increases the water permeability of the resultant membrane. (Specification, p. 6, lines 9-11).

As amended, claim 1 recites a reverse osmosis membrane that "comprises a thin film containing an amino group directly connected to an aromatic ring and a microporous support to support the thin film." Paragraph 23 of the present application discloses a number of suitable aromatic polyfunctional amine compounds that may be used in forming a reverse osmosis membrane in accordance with the present invention.

Claims 1 and 4-6 stand rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 4,353,802 (Hara). In the alternative, claims 1 and 4-6 stand rejected under 35 U.S.C. §103 as being obvious over Hara. To the extent that the rejection still applies to the amended claims, this rejection is respectfully traversed.

Hara discloses a semipermeable composite membrane that includes a polymeric material formed by crosslinking a soluble polymer containing at least 30 mol% of a recurring unit of the formula $-CH_2-CR_4-Y-O-R_3-NR_1-R_2-$, where R_3 is an alkylene group having C_{2-5}. In terms of performance comparison, the present invention (as claimed) requires a permeable flux of 1 $m^3/m^2 \cdot d$ or more under the condition of 500 mg/L of NaCl used at 5 kgf/cm^2. When this value is converted under the conditions disclosed in Hara (*i.e.*, 0.5% NaCl at 600 psi (42.2 kg/cm^2)), the permeable flux will be 8.3 $m^3/m^2 \cdot d$ or more, which is equivalent to 346 L/m^2hr.

A permeate flow rate of a reverse osmosis membrane is proportional to a pressure obtained by subtracting an osmotic pressure from an operating pressure. This can be represented by the following equation:

$$Jv = Lp(\Delta P - \Delta\pi)$$

where Jv is the permeate flow rate, Lp is the permeate coefficient, ΔP is the effective pressure, and $\Delta\pi$ is the difference in osmotic pressure. In a test using a flat membrane (as done here), pressure loss is insignificant such that ΔP equals the pressure of the feed solution. Further, in the present application, the reverse osmosis membranes used both have a high rejection and therefore, $\Delta\pi$, which denotes the difference in osmotic pressure between membranes, can be regarded as equivalent to the osmotic pressure of the feed solution. Accordingly, the permeate flow rate is proportional to the difference between the pressure of the feed solution and the osmotic pressure of the feed solution.

In contrast to the claimed range, the highest permeate flow rate disclosed by Hara is 98.4 L/m^2hr (as shown in Example 3). Therefore, the present invention has flow characteristics that are in excess of three times the maximum performance disclosed in Hara. Because Hara fails to disclose a value that overlaps the claimed value, the claims are not anticipated by Hara. The membranes disclosed by Hara *do not* inherently provide the advantages and properties that result from the claimed structure. Thus, withdrawal of the §102 rejection of claims 1 and 4-6 is respectfully requested.

Additionally, Hara neither discloses nor suggests combining, in an interfacial polymerization reaction, the claimed compounds (namely, an amine group directly linked to an aromatic compound), in order to achieve a reverse osmosis membrane having the claimed properties. Further, the Applicant respectfully disagrees with the Examiner's characterization of the limitations of claim 1 as merely "discovering the optimum or workable ranges." If this

shows a reverse osmosis membrane providing the required flow characteristics. Alternatively, the Applicant requests that the Examiner provide an affidavit detailing the Examiner's personal knowledge pursuant to 37 C.F.R. 1.104(d)(2).

In view of the above, Hara neither shows nor suggests, the present invention as recited in the claims. Thus, the claims are patentable over Hara. Accordingly, withdrawal of the pending rejections is respectfully requested.

IV. Conclusion

Applicant believes this reply to be responsive to all outstanding issues and place the application in condition for allowance. If this belief is incorrect, or other issues arise, please do not hesitate to contact the undersigned or his associates at the telephone number listed below. Please apply any charges not covered, or any credits, to Deposit Account 50-0591 (Reference No. 04558.035002).

Respectfully Submitted,

Date: 4/29/03

#45,079

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APPENDIX A: MARKED-UP COPY OF THE CLAIMS

1. (Four Times Amended) A highly permeable composite reverse osmosis membrane comprising a thin film containing an amino group directly connected to an aromatic ring and a microporous support to support the thin film;

wherein the thin film is formed through an interfacial polymerization by reacting a polyvinyl alcohol-based amine compound having at least two amino groups with at least one substantially monomeric compound having at least two groups that react with the at least two amino groups on the polyvinyl alcohol-based amine compound,

and wherein the highly permeable composite reverse osmosis membrane having a salt rejection of no more than 80% as assessed with a pH 6.5 aqueous solution comprising 500 mg/liter of sodium chloride at an operation pressure of 5 kg/cm^2 and at a temperature of 25 °C.